EXECUTIVE SUMMARY

This Water System Master Plan is an update to the City of Tigard's (City's) 2000 Water System Master Plan. This plan was developed to satisfy the Oregon Health Division (OHD) water master plan requirements as outlined in Oregon Administrative Rules (OAR) 333-61-060. This Executive Summary briefly summarizes the contents of each chapter in the plan, including major activities, conclusions, and recommendations.

ES.1 CHAPTER 1 – EXISTING SYSTEM

Chapter 1 summarizes the existing water system including a description of the Tigard Water Service Area (TWSA), the supply sources, existing infrastructure, and general operations.

System Overview

The City of Tigard supplies potable water to approximately 57,500 people. The Tigard Water Service Area (TWSA) is approximately 13 square miles and includes the majority of the City of Tigard, the Tigard Water District, and the Cities of Durham and King City, as shown in Figure ES.1. The City's water distribution system consists of five major pressure zones, separated by pressure reducing valve (PRV) stations, as shown in Figures ES.2 and ES.3. The 550-foot elevation pressure zone is comprised of several sub-zones that are not physically connected, but share the same hydraulic grade line.

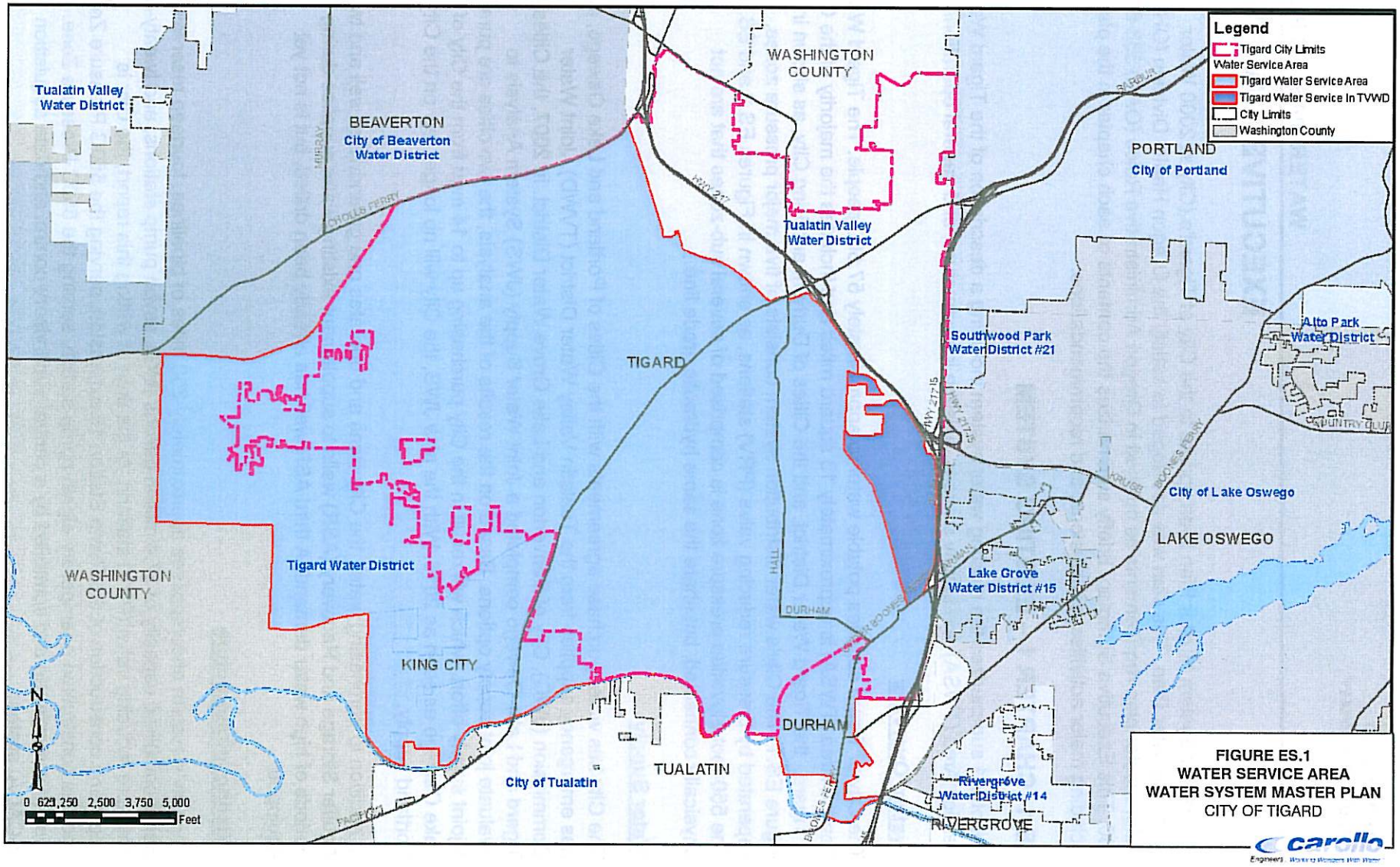
Water Supply

The City has water purchase agreements with the Cities of Portland and Lake Oswego, and has emergency supplies from the Tualatin Valley Water District (TVWD), Joint Water Commission (JWC), City of Beaverton and Lake Grove Water District. In 2007, the Cities of Tigard and Lake Oswego completed a Joint Water Supply (JWS) System Analysis to evaluate joint supply options. Based on the results of the analysis, the two cities are pursuing a joint supply effort, which will result in the City purchasing up to 14 mgd from the City of Lake Oswego as soon as 2016. With the new JWS, the City will no longer rely on the City of Portland supply.

In addition to purchasing water, the City owns and operates one groundwater well and two Aquifer Storage and Recovery (ASR) wells to supplement existing water supplies during periods of high water demand. A third ASR well has already been drilled, but is not yet equipped.

Existing Infrastructure

The City's system encompasses approximately 250 miles of pipelines, fourteen reservoirs with a combined capacity of 27.4 million gallons (MG), seven pump stations, and twenty-one pressure reducing valve (PRV) stations. At the time of writing this report, the City is beginning construction of the Pump Station 10 expansion, serving the 550G Pressure Zone, and has constructed a temporary eighth pump station, serving the 550C Pressure Zone. The system is monitored and controlled by a central supervisory control and data acquisition (SCADA) system.


Legend
Tigard City Limits
Water Service Area
Tigard Water Service Area
Tigard Water Service In TVWD
City Limits
Washington County
Tualatin Valley Water District
BEAVERTON
City of Beaverton Water District
WASHINGTON COUNTY
Tualatin Valley Water District
PORTLAND
City of Portland
TIGARD
Southwood Park Water District #21
Alto Park Water District
City of Lake Oswego
LAKE OSWEGO
Tigard Water District
WASHINGTON COUNTY
Lake Grove Water District #15
KING CITY
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TUALATIN
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FIGURE ES.1
WATER SERVICE AREA
WATER SYSTEM MASTER PLAN
CITY OF TIGARD
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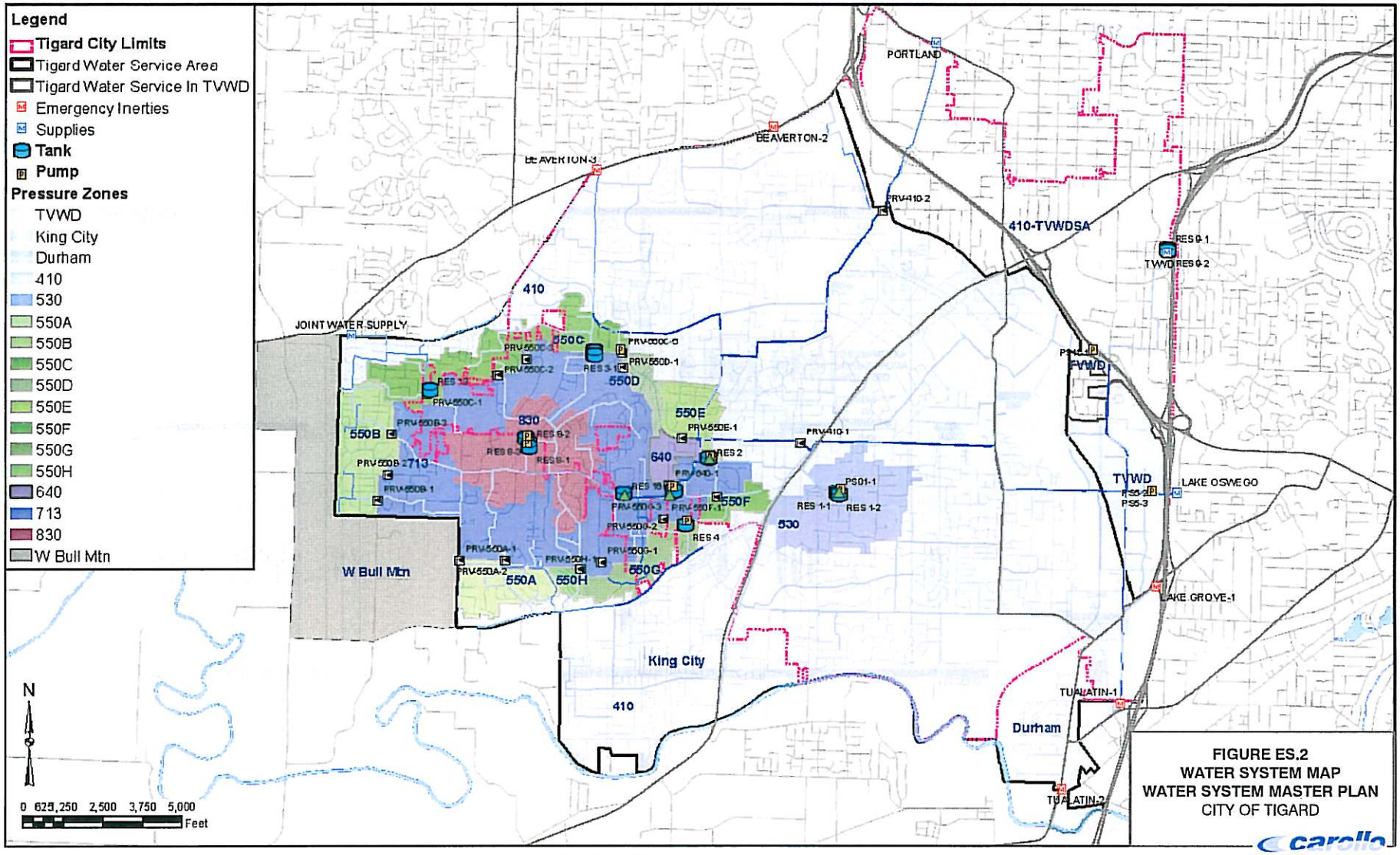

FIGURE ES.2
WATER SYSTEM MAP
WATER SYSTEM MASTER PLAN
CITY OF TIGARD

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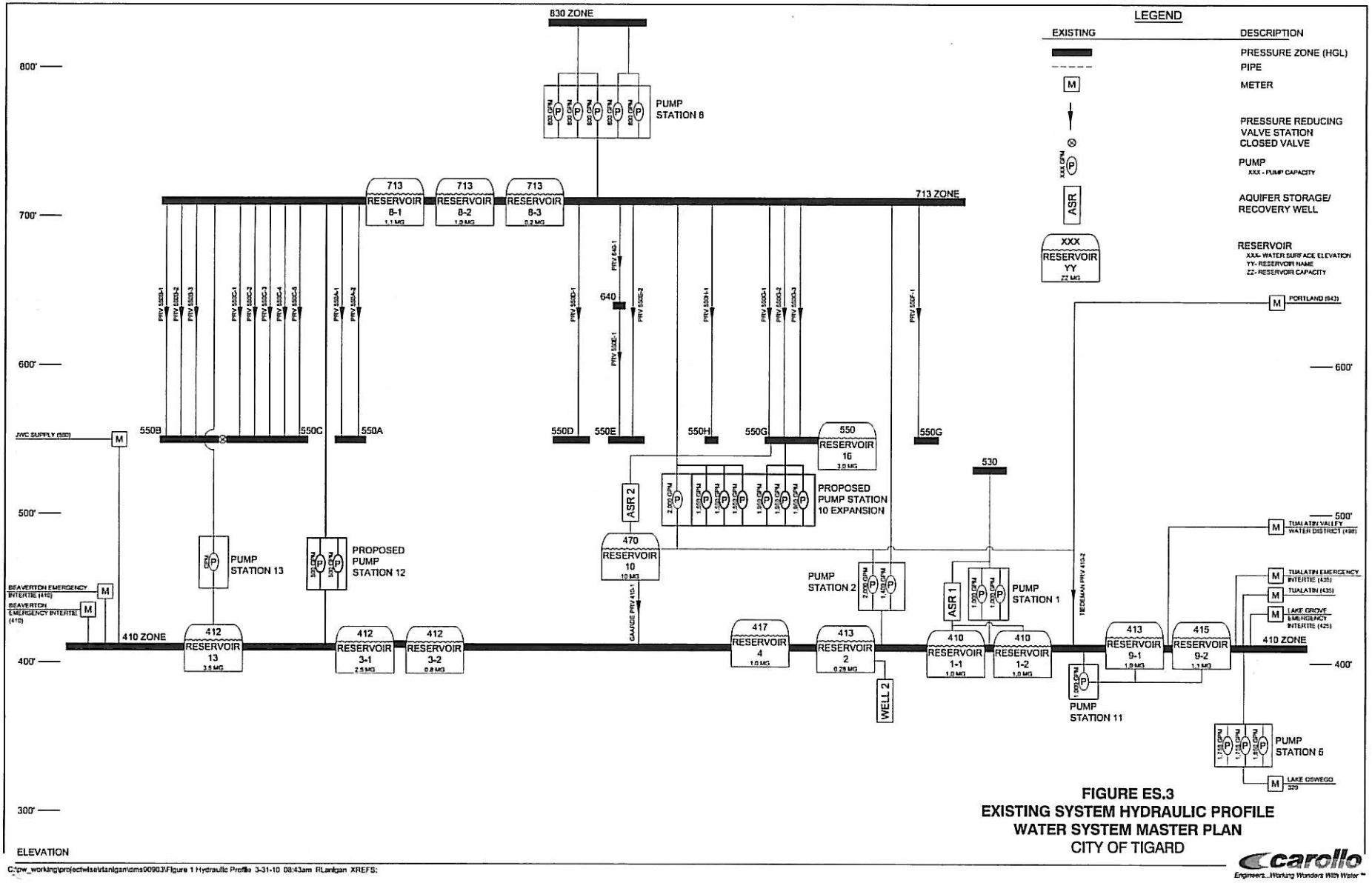

FIGURE ES.3
EXISTING SYSTEM HYDRAULIC PROFILE
WATER SYSTEM MASTER PLAN
CITY OF TIGARD

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ES.2 CHAPTER 2 – POPULATION & DEMANDS

Chapter 2 summarizes the historical and projected population and demands for the City's water system.

Historical & Projected Population

Historical population estimates were based on the number of water service accounts and an average number of persons per account. Population projections combined the future population of the current service area using projections established by Metro's 2035 Transportation Analysis Zone Forecast Allocation, additional development anticipated in the Tigard Urban Renewal and Washington Square Regional Center (not reflected in Metro's data), and the additional West Bull Mountain service area. The total projected population is shown in Table ES.1.

Table ES.1 Projected Population

Year	Metro's Population Projections[1]	Additional Downtown Development[2]	West Bull Mountain[3]	Total
2005	54,757	-	-	**54,757**
2010	57,649	75	-	**57,724**
2015	60,542	149	-	**60,692**
2020	63,435	224	2,959	**66,618**
2025	66,327	299	5,918	**72,545**
2030	69,220	374	8,877	**78,471**

Notes:

1. Estimates are based on Metro's Data Resource Center number of households for 2005 and 2035. Estimated number of households between 2005 and 2035 were interpolated in five-year increments assuming linear growth.
2. Population projections for the downtown development assume development begins in 2010 and grows linearly to 1,000 dwelling units by 2030. Some areas of development occur outside the water service area boundary; populations in these areas are not included.
3. Population projections for West Bull Mountain assume development begins in 2015 and grows linearly to build-out to 3,843 dwelling units by 2035. This number of dwelling units is the average of two possible build-out capacities.

Historical & Projected Demands

In addition to historical population, historical water use data from 2004 to 2008 were used to establish the City's water use patterns, including per capita demands and peaking factors. Though the population has increased, total water usage has generally decreased from 2004 to 2008. The resulting average per capita water demand is 110 gallons per capita per day (gpcd), with a peak day peaking factor of 2.1. Diurnal use patterns established a peak hour peaking factor of 1.7. The projected average day demand (ADD) was calculated by multiplying the future population by the historical per capita water demand, as presented in Table ES.2.

Table ES.2 Projected Demands			
Year	**Population**	**Average Day Demand[1] (mgd)**	**Peak Day Demand[2] (mgd)**
2010	57,724	6.38	13.39
2015	60,724	6.70	14.08
2020	66,618	7.36	15.45
2025	72,544	8.01	16.83
2030	78,471	8.67	18.20

Notes:
1. Average Day Demand (ADD) is calculated by multiplying the population by a per capita usage of 110 gpcd.
2. Peak Day Demand (PDD) is calculated by multiplying ADD by the peak day peaking factor of 2.1.

ES.3 CHAPTER 3 – HYDRAULIC MODEL

Chapter 3 summarizes the development and calibration of the City's water system hydraulic model. The model was developed to facilitate evaluation of the system's ability to meet identified performance criteria under current and future conditions. The model was developed in InfoWater® based on the City's Geographic Information System (GIS) data, and includes all pipelines six-inch diameter and larger. The model incorporated operational settings for pump stations, supply sources, and PRVs, pump curves, pipe roughness coefficients, and the historical diurnal curves based on reservoir level and supply data. Based on the connectivity of the pipes, storage facilities, pump stations, and PRV stations, the system pressure zones were delineated in the model.

The historical demand based on billing data per account was distributed throughout the model using geocoding. Once the geocoding was completed, demand profiles were established for 2009, 2016, and 2030. In each demand profile, the demands within each pressure zone were scaled uniformly to match current and projected water demands.

The model was calibrated by comparing system pressures predicted by the model to data collected during field hydrant tests. System pressures were compared to data from twenty-two field tests; all model results were successfully calibrated to within 10 percent of field tests.

ES.4 CHAPTER 4 – SYSTEM ANALYSIS

Chapter 4 summarizes the capacity evaluation of the City's water supply, distribution system piping, pump stations, and storage reservoirs through the 20-year planning period. This chapter includes the analysis criteria, followed by an evaluation of the existing system and improvements to address identified deficiencies. All the system evaluations were conducted under three scenarios: 2010 (existing system), 2016 (maximum use of Portland supply without Lake Oswego JWS), and 2030 (full Lake Oswego JWS).

Policies & Criteria

Through discussions with City staff, City policies and criteria for providing reliable pressure and flow to City customers were updated. These policies addressed the maximum and minimum system pressures, pipeline velocities, reliable capacity and power sources for pump stations, and operational, fire, and emergency storage required by storage facilities. All analyses were conducted against these established criteria.

Analyses

- *Supply.* The City will require additional supplies to meet the short-term future demands prior to bringing the new JWS online (in 2016). Comparing the existing sources of supply to the projected 2016 demands results in a supply deficit of 2.9 mgd during peak flows. After the JWS is online, the City should be able to meet demands until the year 2030, where a 0.1-mgd supply deficit is anticipated.
- *Distribution System.* Using the hydraulic model, the water system was evaluated under peak flow conditions. No pipelines were found to exceed the established velocity criteria. The system was also evaluated for its ability to meet peak flows under fire flow conditions, including the highest fire flow requirement per service level (based on land use), and for five specific properties as provided by the Insurance Services Offices (ISO). Four areas were identified with fire flow shortages, as well as several small diameter, dead-end pipelines. The largest deficiency identified was for providing fire flow to the 530 Pressure Zone. The system was able to meet all identified ISO fire flows.
- *Storage.* Storage requirements for each pressure service level and for the entire system were calculated using the established storage criteria. Pressure zones and their associated demands were assigned into the 410, 550G, and 713 Service Levels according to how they are served by storage. Demands for the new West Bull Mountain area were also distributed accordingly. The results of the analysis show a large surplus of storage in the 410 and 550G Service Levels, and the overall system, and a 3.1-MG storage deficit the 713 Service Level. Both the 530 and 830 Pressure Zones are not served by storage via gravity.
- *Pump Stations.* The ability of existing pumping facilities to serve their associated service levels were calculated according to the established pump station criteria. Pressure zones and their associated demands were assigned into the 530, 550G, 713, and 830 Service Levels according to how they are served by boosted water. Because the City is in the process of constructing Pump Station 10, this pump station was assumed to be online. In addition to the pumping criteria of meeting peak demands, the service levels were also evaluated for their ability to meet ADD while recharging the ASR wells during off-peak periods. The results of the pumping analysis show that the only pumping deficiency is in the 530 Service Level, which requires an additional 2,200 gallons per minute (gpm) of pumping capacity to meet the fire flow requirements.

Recommended Improvements

Several recommended improvements were identified for addressing the existing system deficiencies. Recommended projects are summarized in Table ES.4, shown on Figures ES.4 & 5, and include the following:

- *Supply.* To ensure the City is able to meet the short-term demands prior to bringing the JWS online, equipping ASR Well 3 is recommended. To fully utilize this source, it is recommended that piping be installed to connect the area served by ASR Well 3 (the 550G Pressure Zone) to Reservoir 10 and to the 410 Pressure Zone near Reservoir 4. Other supply recommendations include development of ASR Well 4, and continued supply agreements with neighboring purveyors prior to implementing the JWS.
- *Distribution System.* One major pipeline improvement was identified that will alleviate the fire flow deficiency in the 530 Pressure Zone, and will provide better system connectivity. This project includes connecting the 530 Pressure Zone to the 550G Pressure Zone, which is served by the new Reservoir 16. This project will allow both system demands and fire flows in the 530 Zone to be served by the reservoir. Five other pipeline improvements were identified to address the fire flow deficiencies, as shown in Figure ES.4.
- *Storage.* Though a storage deficiency was identified in the 713 Service Level, additional storage is not recommended because the City has ample pumping capacity to meet the demands of these upper pressure zones.
- *Pump Stations.* Pump Station 1 serving the 530 Pressure Zone was the only pump station identified with a deficiency. However, by connecting the 530 Pressure Zone to the 550G Pressure Zone, this deficiency is alleviated and Pump Station 1 can be removed. The City will be able to remove some pump stations from service with the planned new pump station. Replacing Pump Station 8 with a new pump station is also recommended.

ES.5 CHAPTER 5 – JOINT WATER SUPPLY INTEGRATION

Chapter 5 reviews the options for integrating the new Lake Oswego JWS into the Tigard water system in 2016. The new JWS will change the hydraulic grade line (HGL) at which the majority of supply enters the City's system, requiring system improvements.

System Configuration

The current water system configuration has the majority of supply (Portland) entering the system at the hydraulic grade line (HGL) of Reservoir 10 (470 feet). The new JWS will enter the system at the 410 Pressure Zone, the lowest pressure zone. Once the Portland supply is offline, much of the JWS supply will be required in the "upper zones," or zones above the 410 Pressure Zone served by Reservoir 10, especially during winter conditions when the ASR wells need to be recharged. Under the current system configuration, the 14 mgd of flow anticipated from the new JWS cannot be conveyed to the upper zones without causing excessive pressures in the 410 Zone. Improvements are needed to convey the required supply up to the HGL of the current Portland supply.

Projected Demands

To identify the required capacities for facilities needed to distribute the JWS, the projected demands for the 410 Zone and the upper zones were evaluated separately. The water requirements in the upper zones include customer demands, as well as ASR Well recharge during the winter. By the end of the planning period in 2030, total winter demands in the

upper zones require half of the JWS supply (approximately 4,300 gpm), especially for recharging the ASR Wells.

Capacity Criteria

Criteria were developed to support development of supply distribution alternatives given the system demands outlined above. The criteria focus on meeting system demands in the upper and lower zones, meeting ASR Well recharge requirements, and utilizing existing infrastructure.

JWS Delivery Alternatives

Two main alternatives were identified to integrate the JWS supply into the City's system to meet the established criteria. Cost estimates were prepared for these alternatives as presented below.

- *Alternative 1.* This alternative includes a 20-inch diameter designated transmission line from a new Pump Station 5 to Reservoir 10; pumping directly from the JWS HGL (320 ft) to the Reservoir 10 HGL (470 ft). A second set of pumps at the new Pump Station 5 would deliver flows to the 410 Service Level. This alternative was estimated to cost approximately $8.3 million.
- *Alternative 2.* This alternative includes replacing Pump Station 5 to deliver JWS flows to the 410 Service Level only, and constructing a separate pump station to boost flows from the 410 Service Level to Reservoir 10. Under this alternative, no designated transmission line is necessary, as the new pump station would draw directly from the 410 Service Level. This alternative was estimated to cost approximately $5.1 million.

Recommended Improvements

Given the cost discrepancy between the alternatives, it is recommended that the City pursue Alternative 2 and construct both a new Pump Station 5 and a new booster pump station. This recommendation has other advantages including a smaller area of impact during construction, and simplified pump design and operation for the new Pump Station 5.

ES.6 CHAPTER 6 – CAPITAL IMPROVEMENT & MAINTENANCE PLANS

This chapter presents a prioritized water system Capital Improvement Plan (CIP) and Capital Maintenance Plan (CMP) for the City.

Cost Estimating

Planning-level cost estimates were developed for each of the recommended CIP projects. These estimates are presented as total project costs in January 2010 dollars, corresponding to an Engineering News Record (ENR) 20-Cities Construction Cost Index (CCI) of 8,660. All costs include a 30 percent estimating contingency, 10 percent for general conditions, 15 percent for contractor overhead and profit, and 20 percent for engineering, legal and administration (ELA) costs. Costs are at a planning level (+50/-30 percent of accuracy) and should be refined as project- and site-specific requirements are further developed.

Recommended Capital Improvements Program

The purpose of the CIP is to document capital projects that are required to improve capacity, improve the level of service, or improve system redundancy. Recommended improvement projects identified in Chapters 4 and 5 were assigned a project identification number and were prioritized and scheduled as presented in Table ES.3. Of the recommended projects, supply- or capacity-related projects were prioritized first, followed by projects addressing deficient fire flows.

Supply-related improvements were scheduled to be completed one year before the year in which they are needed. Beyond the next five years, the implementation timing for the recommended CIP projects was developed in five-year increments. At the request of City staff, fire flow improvements (with the exception of the project addressing the 530 Pressure Zone) were grouped together into a general fire flow improvement category with an annual allocation.

All recommended projects are shown graphically in Figures ES-4 and ES-5.

Recommended Capital Maintenance Program

The purpose of the CMP is to document projects that are required to maintain the current level of service, or renewing the life of existing assets as they reach the end of their design life. Projects identified in Chapters 4 and 5 that fall in the maintenance category include developing an asset management program, performing a reservoir seismic and condition assessment, Pump Station 8 replacement, and annual pipeline, meter, and hydrant replacements. Table ES.4 presents the recommended CMP.

Table ES.3 Recommended Capital Improvements Plan

Capital Improvements Project		Cost	Year	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017-2021	FY 2021-2026	FY 2027-2031
WELL IMPROVEMENTS												
W1	ASR Well 3 – Design & Equip	$ 2,200,000	2011	$2,200,000	-	-	-	-	-	-	-	-
W2	ASR Well 4 – Drill & Equip											
	Siting Study	$ 30,000	2011	$ 30,000	-	-	-	-	-	-	-	-
	Design; Drill & Equip Year 1 (50%)	$ 1,859,000	2012	-	$1,859,000	-	-	-	-			
	Drill & Equip Year 2 (50%)	$ 1,115,000	2013	-	-	$1,115,000	-	-	-	-	-	-
PUMP STATIONS												
PS1	Pump Station 5											
	Design	(1)	2013	-	-	(1)	-	-	-	-	-	-
	Construction Year 1 (67%)	(1)	2014	-	-	-	(1)	-	-			
	Construction Year 2 (33%)	(1)	2015	-	-	-	-	(1)	-	-	-	-
PS2	New Pump Station											
	Siting Study	$ 50,000	2012	-	$ 50,000	-	-	-	-	-	-	-
	Design	$ 255,000	2013	-	-	$ 255,000	-	-	-	-	-	-
	Construction Year 1 (67%)	$ 963,000	2014	-	-	-	$ 963,000	-	-			
	Construction Year 2 (33%)	$ 481,000	2015	-	-	-		$ 481,000	-	-	-	-
PRV STATIONS												
PRV1	New PRV from 550G to 410 Zone	$105,000	2011	$105,000	-	-	-	-	-			
PIPELINE IMPROVEMENTS												
P1	Pipeline connecting 550G and 530 Zones											
	Design	$ 197,000	2011	$197,000	-	-	-	-	-	-	-	-
	Construction	$1,770,000	2012	-	$1,770,000	-	-	-	-	-	-	-
P2	Annual Fire Flow Improvement Allocation	$3,400,000[2]	-	-	-	-	$ 100,000	$ 100,000	$100,000	$1,000,000[3]	$1,000,000[3]	$1,000,000[3]
P3	Pipeline for installing PRV 550G-4	$ 17,000	2011	$ 17,000	-	-	-	-	-	-	-	-
P4	Pipeline in Main St. & Tigard Ave.	$ 101,000	2011	$101,000	-	-	-	-	-	-	-	-
STUDIES												
S1	Water Master Plan Update	$ 140,000	2016	-	-	-	-	-	$140,000	-	-	-
	TOTAL COSTS	**$12,683,000**		**$ 2,650,000**	**$ 3,679,000**	**$ 1,470,000**	**$ 1,063,000**	**$ 581,000**	**$ 240,000**	**$ 1,000,000**	**$ 1,000,000**	**$ 1,000,000**

Notes:

1. Costs included in Lake Oswego/Tigard Joint Water Supply Plan.
2. Includes total cost for $100,000 per year for four years, and $200,000 per year for another 15 years.
3. $200,000 for five years = $1,000,000.

Table ES.4 Recommended Capital Maintenance Program

Capital Maintenance Projects	Cost	Year	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017-2021	FY 2021-2026	FY 2027-2031
MANAGEMENT											
MM1 Asset Management Program	$100,000	2014				$100,000					
RESERVOIR MAINTENANCE											
RM1 Reservoir Seismic and Condition Assessment	$100,000	2015	-	-	-	-	$100,000	-	-	-	-
PUMP STATION MAINTENANCE											
PSM1 Replacement / Upgrade of PS 8											
Design	$210,000		-	-	-	-	-	-	$210,000	-	-
Construction	$1,900,000		-	-	-	-	-	-	$1,900,000	-	-
PIPELINE MAINTENANCE											
PM1 General Pipe Replacement	$70,000	Annual	$70,000	$70,000	$70,000	$70,000	$70,000	$70,000	$350,000	$350,000	$350,000
OTHER MAINTENANCE											
OM1 Meter Replacement	$125,000	Annual	$125,000	$125,000	$125,000	$125,000	$125,000	$125,000	$625,000[1]	$625,000[1]	$625,000[1]
OM2 Hydrant Replacement	$120,000	Annual	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	$600,000[2]	$600,000[2]	$600,000[2]
TOTAL COSTS	**$2,055,000**		**$315,000**	**$315,000**	**$315,000**	**$415,000**	**$415,000**	**$315,000**	**$3,115,000**	**$1,575,000**	**$1,575,000**

Notes:
1. $125,000 for five years = $625,000.
2. $120,000 for five years = $600,000.

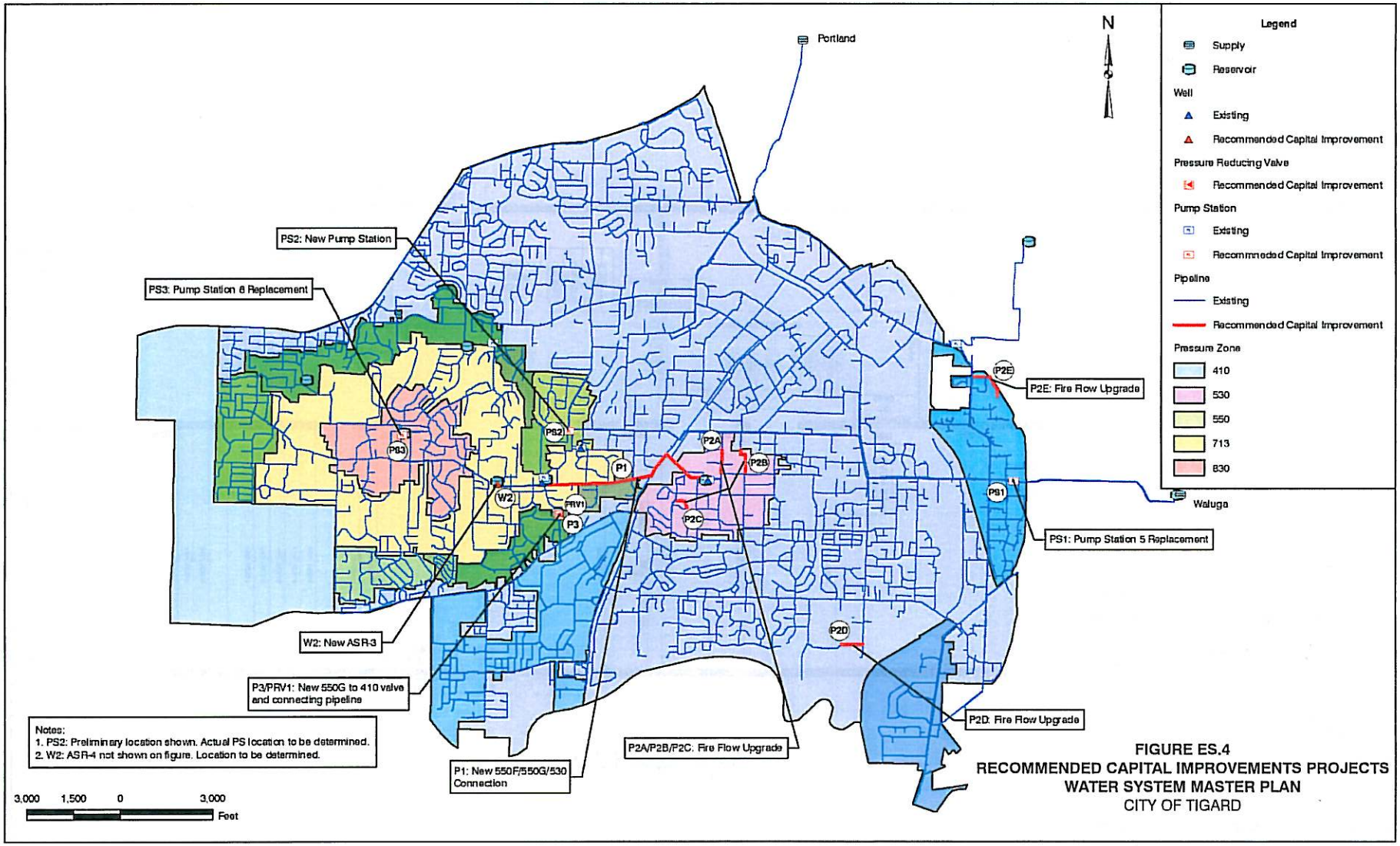

FIGURE ES.4
RECOMMENDED CAPITAL IMPROVEMENTS PROJECTS
WATER SYSTEM MASTER PLAN
CITY OF TIGARD

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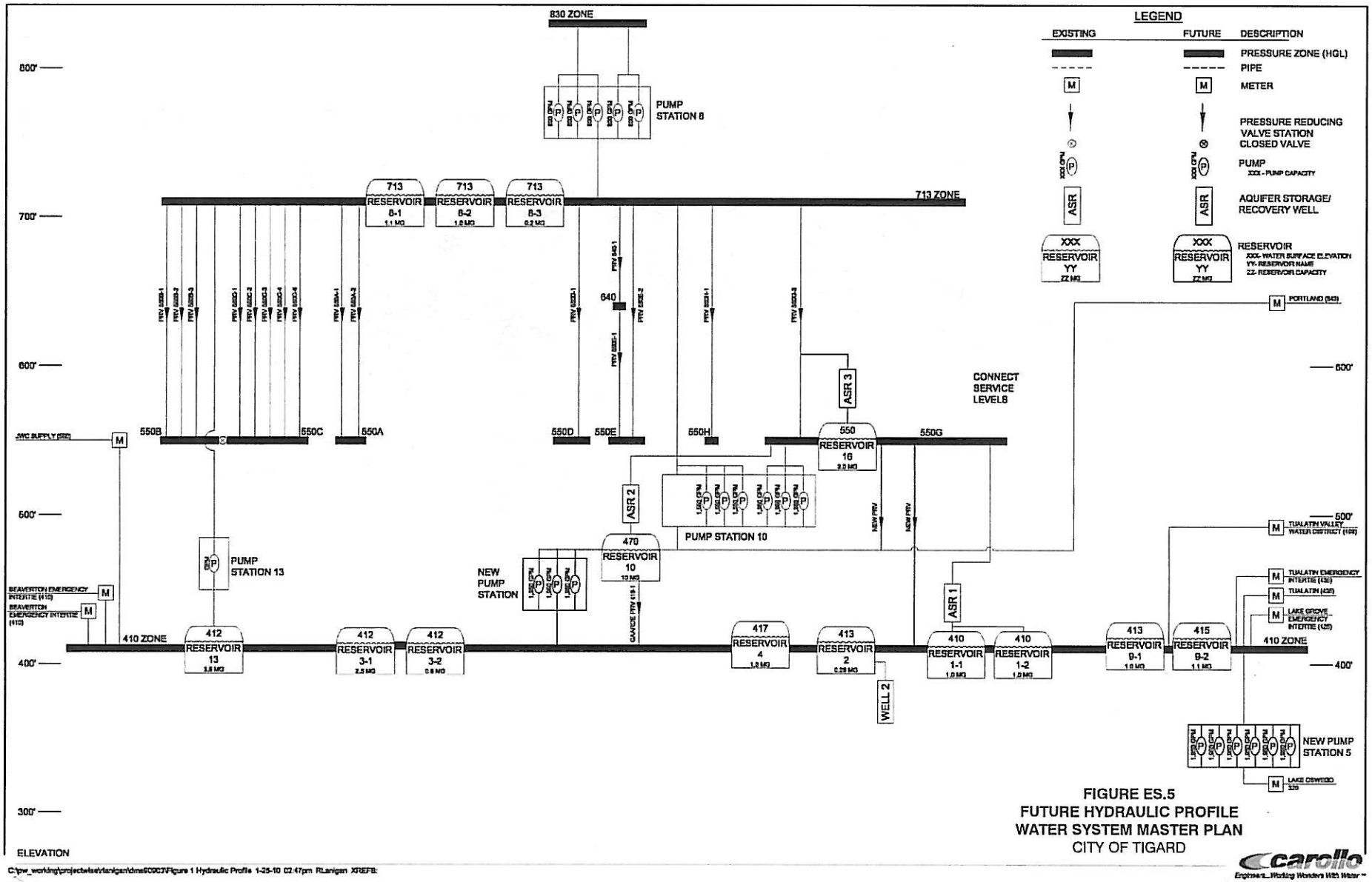

FIGURE ES.5
FUTURE HYDRAULIC PROFILE
WATER SYSTEM MASTER PLAN
CITY OF TIGARD

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Engineers...Working Wonders With Water™

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Other Recommendations

Recommended system improvements and changes that are not included above in either the CIP or CMP, are presented in Table ES.5. These recommendations include facilities that can be taken out of service.

Table ES.5 Other Recommendations

Recommendation	Notes
Pursue short- and medium-term supply agreements with Lake Oswego, TVWD, and/or the JWC.	Required to meet immediate supply shortage prior to completion of ASR Well 3, as well as to provide additional supply through 2016 if ASR Well 4 is not implemented.
Include ability to back-fill to Reservoir 10 in Pump Station 10 design.	Required to allow flows from ASR Well 3 to serve the 410 Zone.
Remove Pump Station 12 from service once the new Pump Station 10 is complete.	This pump station will no longer be needed with the new Pump Station 10 in place and is in poor condition.
Remove Pump Station 2 from service once the JWS infrastructure is complete.	This pump station will no longer be needed under normal operations once the new Pump Station 10 in place, but should be maintained for emergencies until the new booster pump station associated with the JWS (Project PS2) is operation.
Remove Pump Station 11 from service.	This pump station does not have any clear function within the current configuration of the City's system and is no longer needed.
Remove Pump Station 1 from service once Project P1 is complete.	The planned connection of the 530 Zone to the 550G Zone will allow the area currently served by Pump Station 1 to be served by Reservoir 16 and the new Pump Station 10. This pump station will no longer be required and is reported to be in poor condition.
Consider removing the following PRVs from service: 550G-1, 550G-2, and 550F-1.	Upon completion of Project P1, these PRVs will no longer be needed to serve the old 550F and 550G Zones. City staff will determine whether to leave these PRVs in to provide system redundancy, or to take them out of service.
Remove PRV 410-2 (Tiedeman PRV) from service.	Following implementation of the JWS, this PRV will no longer be needed to convey Portland supply to the 410 Zone under normal operations. However, the City may wish to maintain this PRV to distribute supply from Portland during emergencies.

Table ES.5 Other Recommendations

Recommendation	Notes
Convert the Portland supply transmission line into a distribution line in the 410 Zone.	Once the JWS is on-line, the Portland transmission line will no longer be needed. It is recommended that this line be integrated into the 410 Zone by opening existing valves. However, this line should be maintained free of service connections, such that it could be converted back to a transmission line for the Portland supply in an emergency.